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A Colpitt's Oscillator Using SAW Device For Greater Temperature and Frequency Range

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***Abstract*- The latest researches have cleared that the high stability is required to improve the efficiency in the high frequency range. The Colpitt's oscillator is designed for generation of high frequency sustained oscillations. The Colpitt's type of oscillators is widely used for commercial purposes. In this paper we have proposed a new design of a Colpitt's type oscillator using the SAW device in the feedback network for higher frequency range and greater temperature stability. High frequency oscillators are required for the development of mobile, radio communication and other equipment and sensor. The proposed oscillator circuit can operate from lower frequency range to higher frequency range with greater temperature stability. The oscillator circuitry composed of a common emitter amplifier and SAW device in the feedback loop to achieve the sustained oscillations at higher frequency and greater stability for large temperature range. This paper presents design and simulation of the SAW based Colpitt's oscillator which can be used for high frequency range with higher stability for larger temperature range.**

***Keywords*- Colpitt's oscillator, SAW, Greater temperature range, High frequency Colpitt's oscillator.**

I. INTRODUCTION

Greater stability, high frequency, low power consumption and low cost are the requirements of today's communication industry like in mobile communication, wireless communication, radio communication etc.

Earlier the crystal oscillators were used for the high stability clock source in various types of equipments and many applications for greater temperature range. The SAW (surface acoustic wave) device which is being introduced in this paper can perform better than the crystal oscillators which were used for high temperature range, greater temperature range and greater stability.

Surface acoustic wave are the acoustic wave that travel along the surface of the material exhibiting elasticity and the amplitude that decays exponentially with the depth into the substrate. Saw device can perform for high frequency range from few MHz to several GHz. SAW devices have greater stability, high SNR value, and can be mass produced, so the cost of the SAW devices is low than other oscillators.

SAW oscillators are superior in output power than crystal and LC oscillator. The SAW oscillator can operate easily up to several GHz range.

The Saw oscillator here introduced have high temperature characteristic with absolute accuracy within the range between -20ºC to 80ºC. The SAW oscillator is been designed to improve the performance for wide frequency and temperature range. The oscillator here used is the Colpitt's type of oscillator. Colpitt's oscillator is similar to the Hartley oscillator but instead using the tapped inductance it uses the tapped capacitance. The Colpitt's oscillator is used in commercial applications and where the high frequency range is required.

The characteristic of the SAW Colpitt's oscillator is that its frequency shifts towards the higher frequency with temperature, but the performance of the oscillator is stable for large temperature range. It shows a parabolic characteristic for the given temperature range.

II. CIRCUIT DESIGN

The Colpitt's oscillator is composed of the common emitter based amplifier circuit and in the feedback network a SAW device is used instead of the LC tank circuit to achieve the higher frequency and greater temperature stability. The figure (1) shows the common emitter amplifier circuit. The Colpitt's oscillator without feedback network. It consists of a transistor Q, an indicator L1 and capacitors C_{in} and C_{out} which are the coupling capacitor. C_e in the bypass capacitor, R_c is the collector resistor which is for used for controlling the collector current. The input coupling capacitor in used for coupling the ac input voltage to the base of the transistor. As the capacitor C_{in} blocks the dc, and couples the ac component of the input signal. This C_{in} capacitor also ensures that the dc biasing condition of the transistor remains unchanged even after application of input signal. The C_{out} capacitor couples the amplifier output. Re is

connected in the circuit which stabilizes the circuit against the temperature variations. Capacitor C_e is connected to parallel to R_e to provided low reactive path to the amplified ac signal.

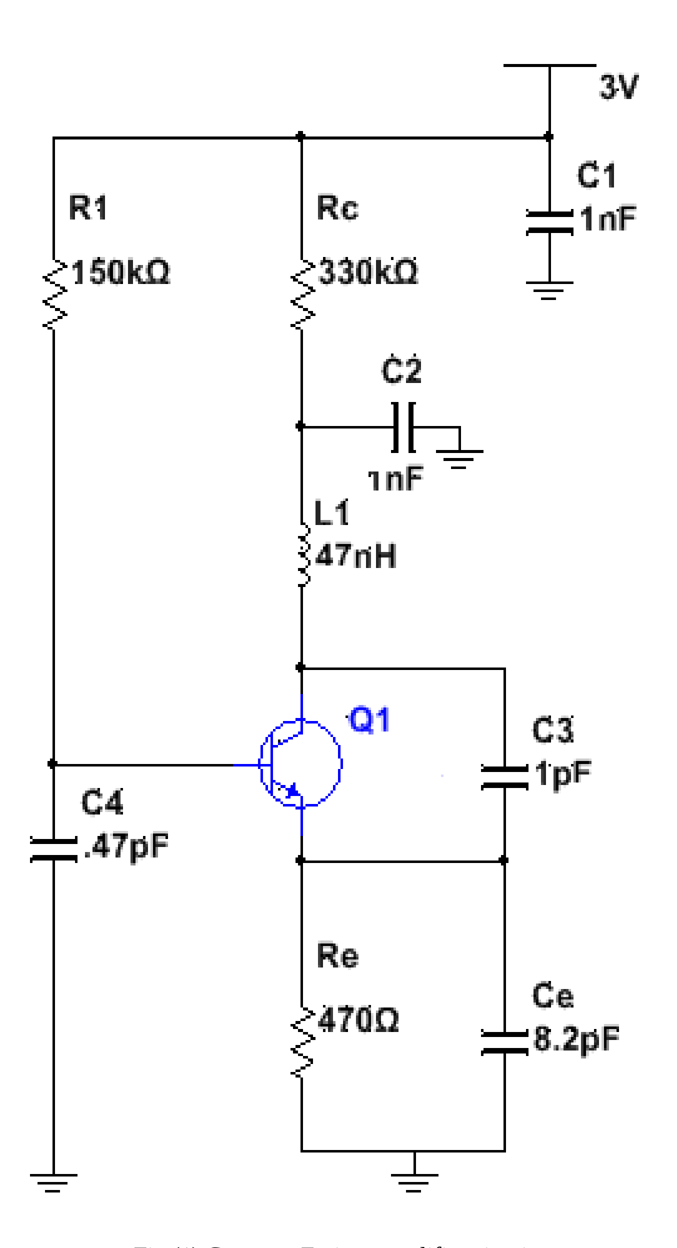


Fig (1) Common Emitter amplifier circuit

The figure (2) shows the schematic diagram to show the Colpitt's oscillator in the circuit using the SAW device in the feedback path. This SAW device increases the frequency, temperature range and stability of the Colpitt's oscillator. The output of the CE amplifier is fed back to the input through the SAW device which is used in the feedback path to give the required phase shift for sustained oscillations.

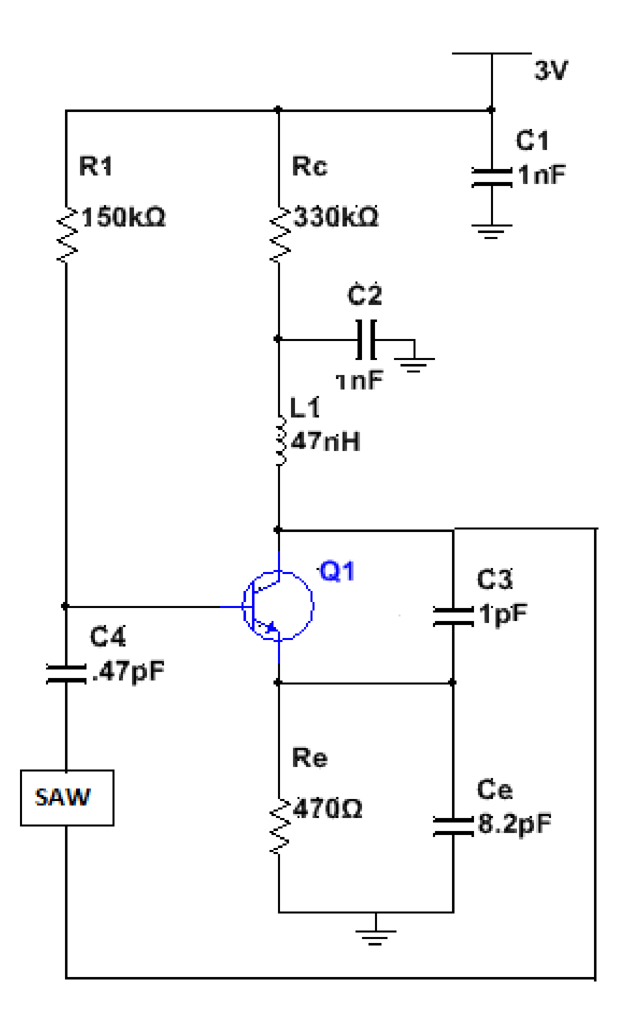


Fig (2) SAW Colpitt's oscillator circuit

III. EXPERIMENT

The proposed SAW Colpitt's oscillator is designed for the higher frequency and greater stability, which achieved by using the SAW devices because they are highly stable in nature. Another requirement which we want to achieve by designed this Colpitt's oscillator is to use this oscillator is to use this oscillator for larger temperature range so-that it can with stand in low as well as at higher temperature. An experiment is been performed to get the frequency response of the designed oscillator with respect to the temperature.

The temperature range for with the designed oscillator perform accurately is -20ºC to 80ºC. The designed SAW Colpitt's oscillator is placed in a PID controlled constant temperature chamber. The frequency response is taken through the spectrum analyser, which shows almost symmetrical parabolic curve for the given temperature range.

The experimental values are given in table 1.

TABLE 1.

Temperature	Frequency
-20°C	433.571 MHz
-15°C	433.681 MHz
-10°C	433.749 MHz
-5°C	433.782 MHz
0°C	433.801 MHz
5°C	433.802 MHz
10°C	433.827 MHz
15°C	433.842 MHz
20°C	433.847 MHz
25°C	433.863 MHz
30°C	433.872 MHz
35°C	433.868 MHz
40°C	433.851 MHz
45°C	433.845 MHz
50°C	433.834 MHz
55°C	433.821 MHz
60°C	433.808 MHz
65°C	433.786 MHz
70°C	433.745 MHz
75°C	433.689 MHz

The experimental values of table 2. is plotted in the graph. The graph shows the parabolic property of the SAW based colpitt's oscillator. It shows the behaviour of the oscillator for the given temperature range is symmetrical.

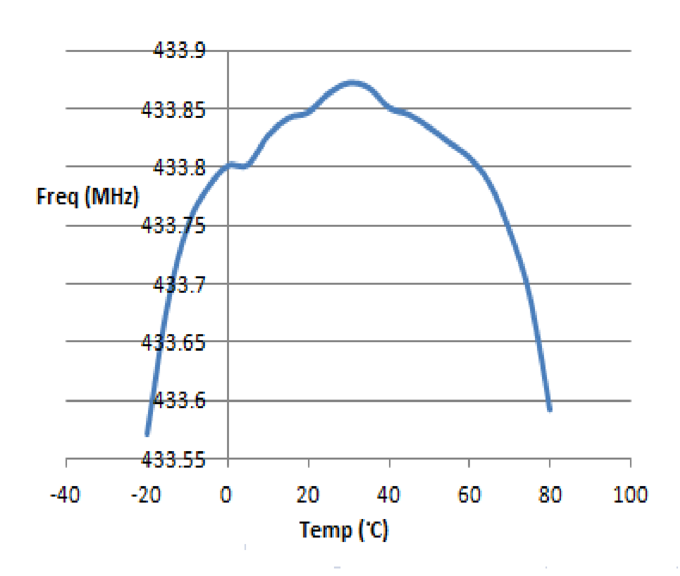


Fig (3) Characteristics curve between frequency and temperature

IV. SIMULATION

The oscillator is designed at 433 MHz and its performance is examined by simulation. The simulation is made by NI multism. The figure (4) shows the simulation of the common emitter amplifier whose frequency is of range 25 KHz. When we use SAW device then it gives the oscillator at the frequency equals to 433 MHz.

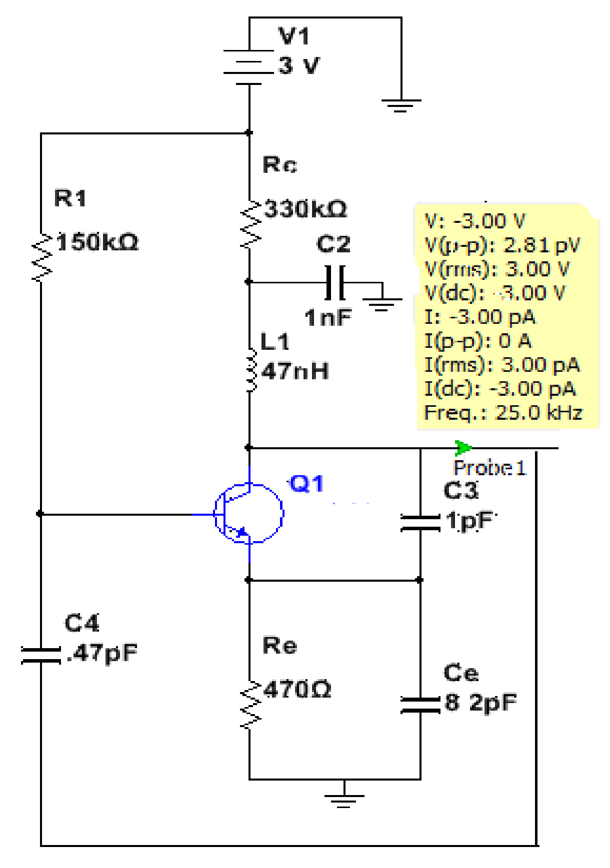


Fig (4) Simulation of CE amplifier circuit

Circuit parameters of the SAW based Colpitt's oscillator used are show in table2.

TABLE 2.

L1	47nH
R1	150KΩ
Rc	330KΩ
Re	470Ω
C1	1nF
C2	1nF
C3	1pf
C4	0.47pF
Ce	8.2pF

The simulation of the SAW Colpitt's oscillator cannot be done on the frequency analyser to the frequency response of the SAW Colpitt's oscillator is shown in figure (5).

The simulation of the Colpitt's oscillator shows that the designed of highly stable at a particular temperature.

The characteristic of this SAW oscillator is that the frequency of this oscillator shifts towards right for high temperature and toward left for low temperature.

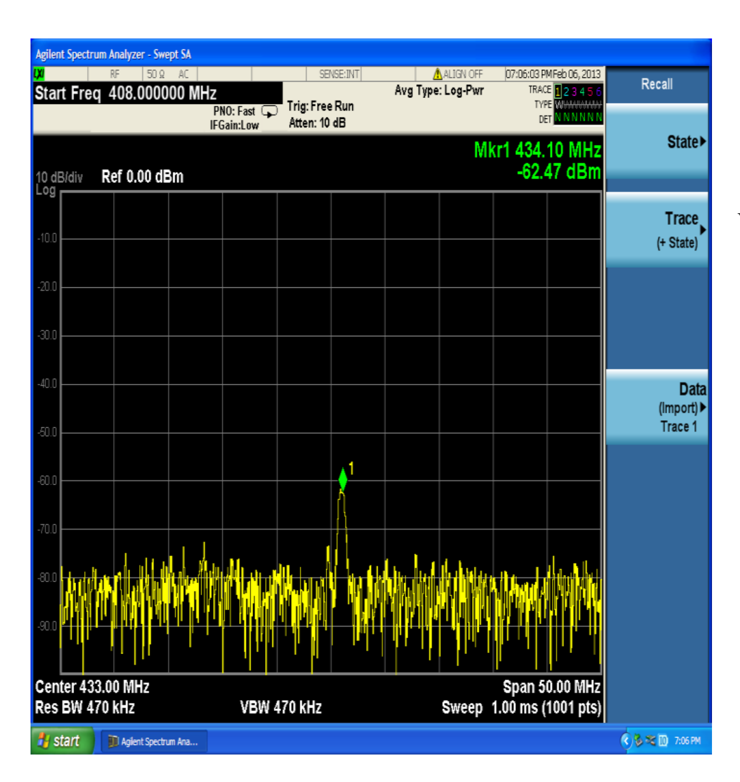


Fig (5) Frequency response of the SAW Colpitt's oscillator

V. CONCLUSION

In this paper, we have proposed a new design of Colpitt's oscillator circuit using the SAW device in the feedback path instead of any tank circuit. The oscillator circuit is designed at 433 MHz frequency, which is highly stable at a given temperature and is evaluated by simulation. The designed Colpitt's oscillator is better than other Saw oscillator because of its temperature stability. From the results, the proposed oscillator circuit is thought to be very useful for the application in the high frequency requirement. The designed SAW can also be used as the different type of sensors example temperature sensor, because the SAW device used in the circuit is highly sensitive to the perturbations and the SAW device directly senses from its surface.

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